Accounting for time-varying and nonlinear relationships in macroeconomic models

de Wind, J.

Citation for published version (APA):
Chapter 1

Introduction and overview

This dissertation is a collection of papers on various topics in the field of macroeconomics, where the greatest common divisor is the desire to capture the time variation and nonlinearities of macroeconomic relationships. This dissertation consists of (i) methodological papers introducing new ways to deal with time variation and nonlinearities in macroeconomic models and (ii) applied papers in which time variation and nonlinearities are key elements of the analysis. Below, I give an overview of the remaining chapters of this dissertation and in particular how they are related to the title of this dissertation “Accounting for time-varying and nonlinear relationships in macroeconomic models.”

Chapter 2, which is joint work with Luca Gambetti, is the first part of a trilogy of chapters on vector autoregressions (VARs) with time-varying parameters. We propose a new, more parsimonious model setup with which we can estimate larger systems than is possible with the model setup of Primiceri (2005), which can be considered as today’s standard time-varying VAR workhorse. The number of parameters in a VAR system with n variables and p lags is equal to $k = n + pn^2$, including an $n \times 1$ vector of constants and for each lag an $n \times n$ matrix of autoregressive coefficients, which quickly gets large when more variables and/or more lags are added to the system. It should be noted that inference is about $k$ time paths of coefficients as opposed to $k$ fixed coefficients as in time-invariant VARs (which are already known to be densely parameterized, allowing for responses of all variables to all variables at all lags). In the standard model setup of Primiceri (2005) only little discipline is imposed on the time paths of the coefficients. More precisely, the coefficients are assumed to follow an unrestricted multivariate random walk, implying that there are as many underlying shocks as coefficients. In Chapter 2 we show that much less underlying shocks are needed and propose a more parsimonious model
setup in which the time variation arises from an underlying factor structure of much smaller dimension. An alternative interpretation is that the covariance matrix of the shocks driving the time-varying parameters is of reduced rank, so we refer to it as the “reduced-rank model.” The implied cross-equation restrictions are shown to be empirically supported and, in addition, we argue that the cross-equation restrictions are theoretically appealing. Moreover, the Bayesian estimation procedure, which had to be modified substantially relative to Primiceri (2005), is much faster due to the much smaller dimension of the underlying factor structure. Altogether, the reduced-rank model proposed in Chapter 2 seems to be a useful new tool for studying macroeconomic questions. With the reduced-rank model we can estimate larger systems than is currently possible, which opens up the world of potential applications.

Chapter 3 is about the influence of the prior on the amount of time variation when estimating VARs with time-varying parameters. I focus on the covariance matrix of the shocks driving the time-varying parameters, which is the key object for determining the amount of time variation in the VAR coefficients. The prior on this matrix turns out to be influential, at least in the small monetary VAR of Cogley and Sargent (2001), which I have used for my analysis. Not surprisingly, also the incorporation of stochastic volatility turns out to be influential. Cogley and Sargent (2005) have extended the model setup they had used earlier in Cogley and Sargent (2001) with stochastic volatility, and in Chapter 3, I show that the estimated amount of time variation in the VAR coefficients would have been much smaller, if they had kept the prior on the covariance matrix of the shocks driving the time-varying parameters unchanged. It should be noted that I have not used the exact same stochastic volatility setup as Cogley and Sargent (2005) but instead the (by now) more standard setup of Primiceri (2005).

Chapter 4 is an application on the time variation in the dynamic effects of changes in tax policy. Using the reduced-rank time-varying VAR model setup that was developed in Chapter 2, I analyze to what extent the dynamic effects of changes in tax policy have changed structurally over the post World War II period in the United States. Like Mertens and Ravn (2013b), I focus on unanticipated changes, which simplifies the analysis because of the absence of anticipation effects. Actually, I exactly follow their identification strategy, which exploits the informational content of a narrative series of unanticipated tax changes to identify the structural tax shock. The distinctive difference with their paper is that I use a time-varying VAR, whereas they use a time-invariant VAR. The time variation estimated in Chapter 4 points to a permanent decline in the tax multiplier as well as a faster response of the economy. Despite the permanent decline,
the estimated tax multiplier is still at the higher end of the range of existing empirical estimates, which is consistent with Mertens and Ravn (2013b). In Chapter 4, I also analyze to what extent fiscal policy has become more countercyclical over time. The results indicate that spending policy used to be procyclical and has become countercyclical after the beginning of the 1990s, whereas tax policy already used to be countercyclical and has become even more countercyclical over time.

Chapter 5, which is joint work with Wouter den Haan, is a methodological contribution in the field of nonlinear numerical solution techniques. We propose a new numerical solution technique to solve Dynamic Stochastic General Equilibrium (DSGE) models with nontrivial nonlinearities. Our procedure starts out with a first-order perturbation approximation, although it is used in a different way than in the regular perturbation procedure, i.e. we use the first-order perturbation approximation for tomorrow’s behavior as opposed to today’s behavior. We then solve for today’s behavior from the exact nonlinear equilibrium conditions under the assumption that tomorrow’s behavior follows from the first-order perturbation approximation and we numerically approximate the expectation with a very accurate numerical integration routine. Relative to the regular perturbation procedure, the numerical integration routine is the only extra tool that is needed, but this is very easy to program. Although we call our numerical solution technique the “perturbation-plus” procedure, it is possible to start out with any numerical approximation. Moreover, it is also possible to iterate on our procedure and obtain a multi-step ahead perturbation-plus approximation. It is easy to program the multi-step ahead perturbation-plus procedure, but it is computing intensive unless the number of steps ahead is chosen to be small. The key advantage of the perturbation-plus procedure is that it is easy to program, so by no means we want to compare its accuracy with a full projection method approximation (which is much harder to implement). We want to compare the accuracy of the perturbation-plus procedure with other procedures that are also easy to program. The easiest thing one can do is using a regular higher-order perturbation approximation, for which standard, user-friendly software is available such as Dynare. However, regular higher-order perturbation approximations are not guaranteed to generate non-explosive time paths. Moreover, regular higher-order perturbation approximations are polynomials and the unavoidable oscillations of polynomials imply that properties such as monotonicity and convexity are not inherited from the true underlying policy functions. Kim, Kim, Schaumburg, and Sims (2008) have proposed the pruning perturbation procedure, which deals with the problem of exploding simulated data but does not alleviate the
problem of undesirable odd shapes. We compare the accuracy of the various perturbation-based approximations on the basis of three models with nontrivial nonlinearities. The regular perturbation procedure produces very inaccurate results due to the problems highlighted before. The perturbation-plus procedure as well as the pruning procedure give a good qualitative insight in the nonlinear aspects of the true solution, but can differ from the true solution in some quantitative aspects, especially during severe peaks and throughs. Chapter 5 has been published in the Journal of Economic Dynamics and Control as Den Haan and De Wind (2012).

Chapter 6, which is joint work with Eric Bartelsman and Pieter Gautier, is an applied paper about the effects of employment protection legislation (EPL) on the sectoral allocation of firms and workers. We show empirically that high-risk sectors, which contribute strongly to aggregate productivity growth, are relatively small and have relatively low productivity growth in countries with strict EPL. To understand these findings, we develop a two-sector matching model where firms endogenously choose between a safe technology and a risky technology. Strict EPL makes the risky technology less attractive as it raises the costs of shedding workers in case of a low productivity draw. So a higher level of firing costs decreases the relative size and average productivity of the risky sector. In addition to the effects of EPL, we are interested in the effects of an increase in the variance of risky-sector productivity, since the arrival of new information and communication technologies (ICT) since the mid-1990s is shown to be associated with an increase in riskiness. An increase in the variance is good for aggregate productivity and is appealing to individual firms as there is no bound on positive shocks while firms have the option to close a job if a sufficiently large negative shock occurs. Interestingly, the effects of the observed time variation in the variance of risky-sector productivity turn out to be very different depending on the level of EPL. In fact, the model predicts that high-EPL countries can take much less advantage of the arrival of new risky technological opportunities than low-EPL countries. This prediction is confirmed by our empirical analysis, which reveals a strong and robust interaction effect of EPL and riskiness on the relative size and productivity of risky sectors. The described interaction mechanism can explain a considerable portion of the slowdown in productivity in Europe relative to the United States since the mid-1990s.

Chapter 7, which is joint work with Pierre Lafourcade, is a methodological contribution in the field of DSGE models and is not directly related to the common themes of this dissertation. We construct a large new-Keynesian DSGE model with a more careful stochastic specification than is standard in the literature. We emphasize the gains, in terms of macroeconomic theory and
econometrics, of including stochastic trends within the theoretical framework of the DSGE model and jointly estimating them with the cycles. We pay particular attention to common trends (or lack thereof) and build our DSGE model around the co-integrating relationships we have found in the data. Our application on the Dutch economy suggests three such trends, namely in general technology, investment-specific technology, and labor supply. The resulting trend-cycle decomposition has a structural interpretation (arising from the theory-based cross-equation and cross-frequency restrictions), which is very valuable from a policy perspective and produces interesting econometric results. First, the trend-cycle decomposition captures the co-integrating properties of the data without which medium to long-run analyses, such as scenario analyses or forecasting, would likely be misspecified. Second, our setup produces better-behaved posteriors for parameters along decision margins where traditional modeling imposes highly persistent but temporary shocks. Third, the co-existence of permanent and temporary disturbances along the same margin broadens the scope for counterfactuals. Specifically, our model extends the insights of the Permanent Income Hypothesis, that consumers respond differently to permanent and temporary income shocks, to the many other forward-looking decision margins. Finally, it should be noted that although we have tailored the DSGE model to the Dutch data, the philosophy of our approach and the methodology are general.

Finally, this dissertation contains a summary in English and Dutch in Chapter 8 and Chapter 9, respectively.